

SCOTTISH SOCIETY FOR RESEARCH
IN PLANT-BREEDING

REPORT

BY THE

DIRECTOR OF RESEARCH

TO THE

SEPT. 1935

ANNUAL GENERAL MEETING

25th July 1935



13/B

1935

R E P O R T

BY

DIRECTOR OF RESEARCH.

I. Research Programme.

The aim of the Society is to promote research for the improvement of plants and crops in Scotland. The crop plants on which breeding experiments are being carried out are chiefly Oats, Potatoes, Herbage (Perennial Ryegrass, Cocksfoot, Timothy, and Plantain), and Swedes. The search for superior varieties of the above-mentioned crops was continued, and the progress of the year's plant-breeding work at the Scottish Plant-Breeding Station is briefly recorded in these pages.

A. CEREALS.

Oats.

Among the practical objectives of the oat-breeding work, resistance to lodging, high yield of good quality grain, early maturity, and resistance to disease are of foremost importance. It is unlikely that there will be secured a variety of oat that will prove to be the best for all the varying conditions of soil and climate in Scotland, and attempts are therefore being systematically made to breed varieties suited to different conditions.

With a view to achieving the above-mentioned objectives,

many oat hybrids were again grown for comparison and selection. Among the fixed hybrids in the more advanced stages of selection and observation there were progenies of the following :—

Potato × Yelder ;

Orion × Yelder ;

Potato × Orion ;

Beseler's Prolific × Orion ;

An unnamed hybrid of the Elder type × An early-ripening hybrid ;

Victory × Potato.

There are a few selections from these hybridisations which are comparatively short-strawed and which give promise of being highly productive and resistant to lodging. They also possess an attractive type of grain. Several other selections have a relatively short growing period, and, since they ripen early, they may be adapted to conditions prevailing in late districts of Scotland. In selecting hybrid types observations have been made on the prevalence of 'dry-fleck' or 'grey-spot,' as this disorder has been prevalent in certain progenies of otherwise promising plants. Many of the hybrids of which Orion was one of the parents have been severely affected with this trouble, especially when warm dry weather prevailed in June.

Three promising unnamed hybrid selections developed at the Station have been sent to the Department of Agriculture for Scotland for inclusion in the Department's Oat Registration Trials this year. These selections were derived from :—

Castleton Potato × Yelder (2) ;

Selection of Elder type × Early-ripening unnamed selection (1).

The new varieties, Elder and Early Miller, have been crossed with other varieties, and some promising material has been secured. When grown in certain areas Elder ripens rather too late, and an endeavour is therefore being made to breed a variety having the good qualities of Elder, but ripening considerably earlier.

Several crosses were made a few years ago with a view to exploring the possibilities of developing an oat having huskless

grain. This type of grain appears to be suitable as chicken-feed, and a group of hybrid progenies containing many huskless grain types was grown for further selection.

Among the unfixed oat hybrids many were grown for comparison and selection and some were grown mainly to provide data on the inheritance of grain colour. Further genetical data have been collected from crosses between black-grained and white-grained varieties, and observations made regarding the occurrence of grey-grained types. Aberrant grey-grained plants have occurred in certain apparently fixed varieties of hybrid origin, and although this is suggestive that natural crossing may have been taking place, it was decided that the question of their origin should be examined. Certain appropriate crosses were therefore made, and the data obtained from one third-generation family derived from first and second-generation plants which were protected from cross-pollination seemed to show that the aberrant grey-grained forms are arising in some way other than by natural inter-crossing. More material has been grown for examination, and about 500 second-generation plants derived from a white-grained variety crossed with a black-grained variety were grown in a greenhouse and protected individually from accidental cross-pollination. The produce of these has been retained for further observation in 1935.

Thirty varieties, the majority of which consisted of unnamed ones raised at the Station, were grown in randomised plots and the yields of grain statistically analysed and compared as in previous years. The prolonged drought in the early part of the growing season doubtless affected yields, as these were below the average. Since many of the varieties were unable to reach near their maximum development, those capable of giving the highest yields of grain would tend to be obscured, and some which did not give high yields of grain will therefore be included in trials in 1935. A number of the unnamed hybrid selections gave yields of grain not significantly different from those given by heavy grain-yielding varieties such as Victory and Eagle. It was calculated that Victory gave a yield of grain at the rate of about 24 cwt. (8 quarters) per acre.

The Society's new oat, Early Miller, in respect of which a Certificate of Registration was received from the Department of Agriculture for Scotland in 1934, was favourably reported

on by many growers last year. Some of the results obtained by growers of this variety in 1934 are shown in Table I.

TABLE I.
SHOWING SOME RESULTS OF TRIALS OF EARLY MILLER
OATS, 1934.

COUNTY.	Yield of Grain per acre.	REMARKS BY GROWERS.
Ayrshire	cwt. 17½	Grown on very light land; suffered from drought; excellent sample.
do.	27	
do. (Auchincruive)	..	Grain yield = 105, Victory = 100. Considerable lodging.
Fifeshire	37	Straw good and crop stood up fairly well.
do.	32	Ripened one week earlier than Beselers; stood up far better; sample plumper and very good.
East Lothian	23½	Some grain lost from wind 'shake.'
do.	30	Very nice sample and crop. Part of acreage affected by drought. Very light land.
Midlothian (East Craigs)	29½	Very little lodging.
do. (Boghall)	25½	No lodging. Grain quality index = 1 (best).
Aberdeenshire (Craibstone)	26¾	No lodging. Second among seven in order of maturity.
do.	29½	Ripened same time as Yelder.
do.	21	The field was a very dry one, and with the dry season the crop was rather short, but yield considered very satisfactory.
do.	27	Straw short.
do.	30	Very severely shaken through straw collapsing before cutting, otherwise yield must have been very high.
Orkney	25½	A few days earlier than Pure Line and from 7 to 10 days earlier than Sandy. Standing power similar to that of Pure Line.

Early Miller has certain characteristics which should be taken into consideration by growers. Since the grain is of medium size, and the young plants tiller moderately well, too thick seeding should be avoided. The rate of seeding will, of course, vary according to the conditions of soil, &c., and therefore no uniform rate can be recommended. It is suggested, however, that in general Early Miller should not be sown much more thickly than Potato oats. At Corstorphine a seeding of five bushels per acre (seed not disinfected) has been found to give a crop of ample thickness. If the seeding is at the rate of six bushels per acre the crop may be too thick, and consequently more liable to lodge. Where lodging is likely to occur it will be better to reduce slightly the rate of seeding rather than to increase it. From some of the reports received it would appear that Early Miller oats should, if possible, be cut before they become dead ripe. If the crop is over-ripe before cutting commences, loss of grain may result through shaking and there is also more likelihood of lodging then occurring.

There was a very keen demand for seed of the Early Miller oat this year. In 1934 the Society grew, under contract, a few acres of this variety and retained all the grain. This grain has again been sown under contract in 1935, about 68 acres being grown.

Wheat.

The hybrid selections from a cross between a variety of *Triticum vulgare* and *T. spelta* were grown, and further selections were made. A few lines which appeared to be breeding true were chosen for a preliminary mass-comparison. Selections were also made from several other hybrid strains for comparison with standard spring-sown varieties.

Barley.

The Field-Trials Sub-Committee, Department of Agriculture for Scotland, recommended that, as there is a need for much purer stocks of Common Scotch barley than those generally available, it would be worth while selecting 'pure' strains of this variety. The Sub-Committee agreed to provide a representative collection of samples of Common Barley from

different crops grown in the North of Scotland, and this was grown at the Plant-Breeding Station for observation. A number of single-plant selections have been chosen for comparison of their progenies in 1935.

B. POTATOES.

Assistant in Charge—WILLIAM BLACK, B.Sc., Ph.D. (Ainville Sub-Station).

The work with this crop is concerned mainly with the creation of outstanding new varieties of commercial value and the collection of information regarding heredity in potatoes.

One of the chief hindrances in potato-breeding is the scarcity of efficacious pollen-producing varieties which can be used as male parents, most of the best-known varieties being practically male sterile. Some of the Society's new selections, however, produce viable pollen in quantity, and one of these, the new seedling, 'The Alness,' has been freely used as a male parent with very promising results. As a parent of seedlings raised in 1934, it was used in combination with the varieties Arran Comrade, Catriona, Golden Wonder, Kerr's Pink, Majestic, and Up-to-Date, and these hybridisations provided a wide range of types. The seedlings of Catriona $\times$ The Alness contained over 60 per cent of distinctively marked tubers, the colour pattern ranging from self-coloured to practically white, and the colour intensity from deep to very faint. Both reddish-purple and bluish-purple types were represented. In the case of Golden Wonder $\times$ The Alness almost all the seedling tubers were either kidney or long in shape, and over 70 per cent were faintly coloured, some reddish-purple and some bluish-purple. Several other varieties were also used as male parents of which Herald and Pepo gave a number of promising types.

The effects of repeated self-fertilisation were further noted on about 600 seedlings. An endeavour has been made to raise a generation from the true seed each year, but frequently the difficulty in selecting parents from unknown seedlings has necessitated waiting until the second year before the succeeding generation could be secured. Certain lines, however, have now reached the seventh generation, and amongst them wide differences are still apparent. Some of them have remained strong and vigorous and yielded good

crops of tubers, while others have lacked vigour and displayed signs of degeneracy. The advent of this degeneracy does not appear to be due to disease, but to the unfavourable combination of hereditary units possessed in latent form by the parent plants. Among the varieties originally utilised in these experiments were Flourball, General, Langworthy, and Majestic, and useful information has been obtained regarding the distribution of various characters in their successive selfed progenies. While none of the inbred plants is yet true-breeding, some of them appear to be approaching that stage.

Certain wild solanums, indigenous to Central and South America, possess desirable qualities such as resistance to virus diseases, blight, frost, and drought. Over 450 seedlings descended from some of these species were grown in continuance of the experiments designed to ascertain the possibility of introducing certain of these desirable characters into cultivated varieties. In 1934 the seedlings consisted almost entirely of hybrids between different wild species on the one hand and of second-generation progenies obtained by selfing the hybrids of wild $\times$ cultivated types on the other. The former produced nothing of immediate commercial interest, but the latter contained a wide range of types, among which there were several worthy of being used for further breeding. It is intended to backcross some of the best of these to the cultivated parent.

The most successful results in the second-year seedlings from crosses between cultivated varieties were obtained from the Up-to-Date $\times$ Alness hybrids, which contained an unusually high proportion of promising plants. Several excellent types were also obtained from Arran Rose $\times$ Majestic and British Queen $\times$ Alness. About 170 selections of third-year and older seedlings were grown in trial and multiplication plots and their characters compared with standard varieties. Samples of the majority of them were also grown at other centres—*e.g.*, Craigs House, East Craigs, Philpstoun, Huntly, and Ormskirk.

A number of samples were grown in the preliminary trials carried out by the Ministry of Agriculture and Fisheries at Ormskirk. In the Ministry's Wart Disease Immunity Trials five varieties were included in the first year's and one in the second year's test.

The Registration Trials carried out by the Department of Agriculture for Scotland included eleven of the Society's

varieties : seven in the first year's trial, three in the second, and one in the final. The latter was registered, and will be referred to later. Of the others, three were recommended for further trial—viz.: 967c(38), 212a(III), and 264(37). They are briefly described in Table II. Seedling No. 967c(38) has successfully passed the second year's trial, and will be included in the third year's trial in 1935, when it may be considered for Registration. It is a maincrop variety, and it is noteworthy on account of the blight-resistant qualities of its haulm. The foliage is abundant and the tubers are shapely and of very good quality.

In 1934 the Society received a Certificate of Registration from the Department of Agriculture for Scotland in respect of a new potato seedling, Reference No. 135(10), and now known as 'The Alness.' This variety was secured by crossing the varieties, Abundance and Majestic. It is an early second-early, and possesses shapely tubers of excellent cooking quality. The following is the official description of The Alness :—

Maturity.—Second-early.

Tuber.—Oval, skin white, flesh white, eyes shallow, sprouts pink.

Foliage.—Haulm medium height, spreading; wings straight; leaf open, rigid; leaflets broad, ashy green, terminal leaflet well clear of last pair of laterals.

Flower.—White, anthers orange, stalks strong; buds dark; berries occur.

The stock of The Alness was multiplied for the Society under arrangements made with Mr John Chisholm, at Gibston, Huntly, in 1934, and a Stock-Seed Certificate in respect of the crop was granted by the Department of Agriculture for Scotland. The produce amounted to about four tons, and small quantities of this crop were offered to members of the Society in February 1935 at £5 per cwt. In all 26½ cwt. were distributed to members.

As a result of the various trials in 1934 seven new seedlings have been selected for inclusion in the Registration Trials carried out by the Department of Agriculture for Scotland, and one in the Wart-Disease Immunity Trials of the Ministry of Agriculture and Fisheries in 1935. They are briefly described in Table II. which follows.

THE ALNESS.



FIG. I.

A photograph showing the finely shaped tubers of the above variety. The tubers were taken from the field crop which was grown entirely for seed for the Society in 1934 by Mr John Chisholm, Gibston, Huntly.

This variety was awarded a Finlayson Gold Medal as one of the seedling potatoes accepted for Registration in 1934.



FIG. II.

Types of 'diploid' Timothy with 'hexaploid' Timothy (top right)
for comparison.

TABLE II.

NOTES WITH REFERENCE TO PARENTAGE, ETC., OF
ELEVEN PROMISING UNNAMED SEEDLINGS.

Reference Number.	Parentage.	Maturity.	Tuber.		Cooking Quality.
			Shape.	Colour.	
967c(38)	Bishop × 800(2)	Maincrop	Oval	White	Very Good
212a(111)	Epicure × The Alness	1st-Early	Kidney	White	Good
264(37)	Majestic × The Alness	2nd-Early	Kidney	White	Good
134(5)	Abundance × Flourball	1st-Early	Oval	White	Good
134(139)	Abundance × Flourball	2nd-Early	Oval	White	Good
257(47)	America × The Alness	1st-Early	Round	White	Very Good
306(71)	42667 (U.S.D.A.)	Maincrop	Round	White	Good
306(131)	42667 (U.S.D.A.)	Early- Maincrop	Oval	White	Good
316a(4)	British Queen × The Alness	Early- Maincrop	Oval	White	Very Good
322(35)	966f(1) × Herald	2nd-Early	Kidney	White	Good
322(70)	966f(1) × Herald	Maincrop	Oval	White	Very Good

C. HERBAGE PLANTS.

Assistant in Charge—J. W. GREGOR, Ph.D., F.L.S.

Three new grass strains were laid down in a series of field trials by the three Scottish Agricultural Colleges during 1933.

In the same year, and in 1934, these strains plus a fourth one were sent to a few members of the Society for inclusion in trials varying in size from two acres to several square yards. The strains comprise the following: (a) a soft-leaved cocksfoot; (b) a decumbent 'diploid' timothy; (c) an erect 'diploid' timothy; and (d) a pasture strain of perennial ryegrass. The available information from all trial sources regarding the behaviour of these strains suggests that the cocksfoot and one of the 'diploid' timothy strains justify further seed multiplication. Accordingly, three acres of cocksfoot (Reference No. Cc 180) and four acres of 'diploid' timothy (Reference No. Cb 191) have been sown for seed under contract this year.

The study of races of 'diploid' timothy and the relationship of this type to the commonly cultivated 'hexaploid' type have been further pursued. The experiments indicate that the two types of timothy have distinctive uses in pasture. The 'diploid' variety is essentially a pasture type and it is unlikely that it will ever seriously compete with its tall-growing 'hexaploid' relative as a hay plant, although in a pasture it is possible that both types may be of value. In general, the 'diploid' timothy differs from the 'hexaploid' in possessing races better adapted to districts with a low rainfall and free-tillering growth forms which can withstand the conditions of severe grazing. The former can therefore be regarded as a bottom grass, and as such it need not necessarily replace the 'hexaploid' type in a pasture mixture, but should be regarded rather as a suitable substitute for a grass with the habit of growth of crested dogtail. Nevertheless, in certain circumstances—*e.g.*, dry heavily grazed pastures—the complete substitution of 'diploid' for 'hexaploid' timothy may be profitable. This, however, can only be ascertained when the results of agronomic experiments accumulate.

In 1931 various European samples of timothy were sent from the Station here to the Macdonald Agricultural College, Ste Anne de Bellevue, Canada, for rust-resistance experiments. From these samples Mr Norman Bird of the staff of the College has selected a strain of 'hexaploid' timothy which is a heavy yielder and is highly resistant to rust attack under the conditions prevailing at Ste Anne. This timothy and a new pasture strain of perennial ryegrass are included in the first-year seed multiplication plots at Craigs House in 1935.

The investigation of races of sea-plantain, a research pro-

gramme planned to contribute information concerning technical problems relating to the breeding of herbage strains, has been continued. Although this work has been in progress for the last eight years it is too early to draw final conclusions from the experiments as the data collected are only now beginning to be sufficient to allow of a satisfactory analysis being made. Nevertheless, from a preliminary examination of the results, it can be confidently stated that so far as the classification of wild habitats goes, a definite connection exists between the size of many plant characters and the environmental conditions under which the plants are grown.

In a previous report it was pointed out that one of the aims of the above research was to collect information which would be of value in breeding agricultural strains specially adapted to particular environmental conditions. In view of the approaching introduction of new herbage strains into commerce, a problem equally deserving attention is that of preserving new strains at their original level of purity. The cross-fertilising herbage strains, unlike the self-fertilising cereal varieties, are much less uniform, and contain numerous growth types. The proportions of these types originally present in a strain are subject to alterations should conditions favour the increase of some types more than others. A strain is also liable to an automatic change in type, and this change may proceed even when the environment has ceased to exert its selective influence. It is therefore considered necessary to develop methods for the detection of deviations from the original proportions, and to study the factors which tend to produce such changes in strains.

D. ROOT CROPS.

(Swedes and Turnips.)

Assistant in Charge—V. E. M'M. DAVEY, B.Sc., Ph.D.

The main purpose of the experiments with swedes is the examination of various methods for the selection and comparison of individual plants, intended for use in breeding, with a view to obtaining improved strains or varieties.

Pedigree Breeding.—About 240 strains of swede were sown in various groupings, with certain commercial varieties as controls. As usual, the smaller samples and all the pedigree lines were sown in small plots on the flat with special precautions for even spacing; and a small yield trial was similarly prepared. Samples of unfixed strains and a second series of the pedigree lines were sown in larger plots, or in yield trials in drills. Plots of practically all the strains had been sown before 11th May, and good crops were thereby obtained despite the adverse season which caused bad brairds of the later sowings. Observations were made periodically throughout the growing season, and in the autumn representative selections were made for propagation.

Most of the older lines were in their sixth self-fertilised generation and comprised a series of the different types of swede. The more promising lines have at various times been crossed with one another, supplying the numerous unfixed strains from which most of the new selections are now made.

Controlled Seeding.—About 190 strains of swede were harvested from the selected plants out of the 1933 crop. There were sixteen hand-crosses, three strains mass-multiplied under natural isolation, and the rest individual plants self-fertilised under bag isolation.

Diseases.—A new and larger break was employed for testing resistance to finger-and-toe disease. It was infected with *Plasmodiophora* nodules from swede bulbs. Though the soil fertility was uneven, the disease was prevalent throughout the break. A number of pedigree and unfixed strains were tested, using Danish resistant varieties as controls. Some strains were exterminated, while others showed degrees of resistance. Individual plants apparently free from the disease were kept for propagation.

The season was not favourable to mildew attack, though the disease appeared for a time. Some material was prepared for workers at the Royal Botanic Garden who were making investigations on this disease.

Analysis of Hereditary Characters.—Further observations were made on the manner of inheritance of various characters, such as yield, dry-matter percentage, shape of bulb, colour of flesh and skin, shape of leaf, splitting and bolting.

Variation.—Discoloration of the swede leaf by yellow mottling may be due to several causes. For example, there

is the accidental damage due to top-dressings, &c. Swedes in their first year are not subject to the marked discolorations that may be seen on the leaves of common turnip, and which have been attributed to lack of certain plant foodstuffs. In the second year of growth, however, it is not uncommon to find swedes exhibiting yellow mottling on their leaves, and in such cases there seems to be no hereditary effect in the progenies.

An apparently rare type of variegation in swedes has been observed. Such plants exhibited mottling on their leaves from the seedling stage throughout life, irregular patches of light yellow or light green being found, chiefly round the margins of the leaves. A plant of this kind was propagated and three lines bred from it for three generations. All the offspring have shown the variegation, though the area of discoloration varied greatly. When crossed with a normal green-leaved swede the variegation was not observed in the first generation, but reappeared in about one-quarter of the second generation. It would appear, therefore, that this abnormality is hereditary, being a simple recessive character, though some further observations will be necessary for confirmation.

Yield Trials.—Several small yield trials were laid out, but, as most of these were seriously affected by the unfavourable season, investigations were confined to a trial of F₃ lines. Some 50 strains had been obtained from a single cross between a hardy green-top and an early purple-top swede. Plots of these third-generation strains had previously been tested in the trials of 1933. Seed of the same samples was, in 1934, sown in one 4-block trial. From measured strips containing approximately equal numbers of plants, series of bulbs of each strain were weighed and tested for dry-matter percentage individually. An attempt was thus made to observe the relative variabilities within the unfixed strains, as well as the average differences between the strains.

Requests are occasionally received from other Research Stations for an exchange of some experimental material on a reciprocal basis, and when such exchanges are made the results are often of scientific and practical interest to both parties. A few years ago a request was received from the Director of Plant-Breeding, New South Wales, Australia, for a few small samples of swede seed for experiment. Seed

was supplied and information has recently been received from the Director of Plant-Breeding that one of the strains of swede has been giving outstanding results in New South Wales, and that it seemed to be very well adapted to part of that area. This swede has also been under observation in some of the larger swede trials at the Scottish Plant-Breeding Station in recent years, and in these tests it appeared to merit further trial. The main defects it exhibited at Corstorphine were a rather low dry-matter content and a slightly coarse 'neck.' In view of the report from New South Wales this variety will be further tested.

E. VIRUS DISEASE RESEARCH.

E. C. BARTON-WRIGHT, M.Sc., F.R.S.E., *Chief Assistant, Craigs House.*

GEORGE COCKERHAM, B.Sc., *Assistant, Huntly Sub-Station.*

ALAN M. M'BAIN, B.Sc., *Assistant, Ainvie Sub-Station.*

Plant-Breeding Station, Corstorphine.—The physiological investigations dealt with nitrogen metabolism of potatoes affected with crinkle, and the results obtained were described in a paper read by Mr E. C. Barton-Wright at the Conference of Virus Disease Workers held at East Craigs, Corstorphine, on 10th July 1934. It was pointed out that there appeared to be considerable interference with the normal transport of nitrogen to the tubers, although no visible necrosis of the conducting tissues could be discovered in the diseased material. The main points of difference between healthy and crinkle-affected plants were: (1) synthesis of protein in diseased plants takes place at a later time in the growing season than in healthy ones; (2) there is a retardation of hydrolysis of protein in the crinkle-affected plants; (3) there is interference in such plants with the normal channel of transport of nitrogen fractions.

The breeding work with potatoes was continued with the object of ascertaining (*a*) whether any segregation was shown in the progeny of a 'selfed' variety which is resistant to natural infection with virus diseases, and (*b*) whether it was possible to synthesise an improved resistant form. The variety Shamrock appears to have a high degree of resistance to

virus disease, and it also possesses viable pollen. Seed from 'selfs' of this variety was sown, and over 300 seedlings were grown in an infectious environment. The seedlings could be classified into two groups: (1) those apparently healthy, and (2) those showing symptoms of infection with virus disease. Hybrid progenies from Epicure $\times$ Shamrock and Epicure $\times$ Pepo were also grown in the infectious environment of Corstorphine for observation and comparison.

In accordance with instructions received from the Department of Agriculture for Scotland, economies had to be effected in the expenditure on the virus-disease investigations during the financial year 1934-35, and the Society had therefore to dispense with the services of Mr E. C. Barton-Wright, one of their workers on virus diseases of potatoes, as from 1st October 1934.

The collection of seedling tubers raised in the experiments conducted by Mr Barton-Wright have been examined and classified. Material has been selected from this collection, and it will be used in further breeding experiments under the virus-disease investigation.

North of Scotland Sub-Station, Gibston, Huntly.—Problems bearing upon the resistance of potato varieties to virus disease have been further examined. Evidence has been obtained of the existence of two distinct types of resistance—viz., resistance to natural infection and resistance (tolerance) to the pathogen after infection has taken place. Although no variety or seedling yet examined has proved to possess complete resistance to all the potato viruses of major importance, a high degree of tolerance to individual viruses has been exhibited by some of them. The genetical aspects of these problems have been followed up by the raising of seedling progenies from parents which have shown either a high degree of susceptibility or a high degree of tolerance to specific viruses. Hybrid progenies derived from susceptible and tolerant parents have also been raised. Further breeding on these lines has been accomplished.

The data obtained from the investigation into the relation between virus diseases and reproduction in the potato have been prepared for publication. These data refer to the effect of virus diseases on flower, fruit, and seed production, and problems relative to seed transmission of virus diseases and degeneracy are discussed.

A comprehensive test has been made of the copper strip

method advocated by Appel for ascertaining the presence or absence of virus in potato tubers. These tests were made upon 600 tubers from 53 varieties at frequent intervals over the period of winter storage. The method was found to be of little value—a conclusion reached by other workers in this field.

The investigations into the metabolism of healthy and mosaic-infected potatoes have been concluded, and the data obtained have been examined statistically and prepared for publication. Anomalies in the carbohydrate economy of diseased plants have been found to be slight but definite in direction, and have been correlated chiefly with the disease symptoms shown. Disturbances in nitrogen metabolism, on the other hand, have been found to be of relatively greater degree, the total nitrogen contents of laminae and petioles of mosaic-infected plants being significantly higher than those of corresponding healthy plants. The early ripening of diseased plants and the lower yields of tubers produced by these appear to be due to disturbances in metabolism which result in reduced 'growth' activities.

The Society's lease of ground at Gibston, Huntly, where some of the virus disease investigations have been conducted by Mr Cockerham, expired at Whitsunday 1934. The proprietor of the ground allowed the work to continue until November 1934, but he has now intimated that he will be unable to grant further permission for virus-disease investigations being continued there. It has therefore been arranged that Mr Cockerham will continue his investigations at Craigs House, Corstorphine.

The transfer of material from the North of Scotland Sub-Station to Craigs House and Ainville has been completed. Arrangements have also been made for the continuation of the work upon the comparative reaction of potato varieties and seedlings to artificial infection with the three viruses 'X,' 'Y,' and leaf-roll. Selfed and hybrid seed obtained during the summer of 1934 from susceptible and resistant parents has been sown for the purpose of raising seedling progenies for test in 1936.

Ainville Sub-Station, Kirknewton.—It has been demonstrated that potato varieties can be grouped into three classes with respect to their resistance to natural infection from the virus causing leaf-roll. The variety Shamrock merited being placed in the most resistant class. An endeavour has been made to

discover if this resistance is transmitted through the true seed. 500 selfed seedlings from Shamrock and hybrid seedlings derived from susceptible $\times$ resistant plants were raised, and these will be tested under field conditions in 1935 for frequency of infection with virus diseases. The varieties Epicure, Di Vernon, Catriona, British Queen, Dunbar Cavalier, and Abundance have been crossed with Shamrock, and each plant that was crossed with that variety was also crossed with the susceptible variety Pepo, for comparison. 'Selfs' of Pepo have also been secured.

In all the progenies raised the haulm and tuber characters of the seedlings have been noted with the object of ascertaining whether any linkages exist. Selections will also be made from this material for use in further experiments.

II. Publications and Lectures by Staff, for the Year ended 31st March 1935.

PUBLICATIONS (P) AND LECTURES (L).

Director of Research :—

"Experimental Oat and Potato Breeding." Transactions of the Highland and Agricultural Society of Scotland, Fifth Series, Vol. XLVI., 1934. (P)

"Oat Breeding in Scotland." The Empire Journal of Experimental Agriculture, Vol. II., No. 7, July 1934. (P)

"Inheritance in Oats, with Special Reference to Striped Leaves." Proceedings of the World's Grain Exhibition and Conference, Canada, 1933. Vol. II. (P)

"A review of developments in Oat Breeding." Chirnside Agricultural Discussion Society, 20th February 1935. (L)

J. W. Gregor, Ph.D., F.L.S. :—

"Some aspects of the crop plant variety problem." General Conference of the Agricultural Education Association. London, 12th December 1934. (L)

"The crop variety problem." Glasgow University Botanical Society, 5th February 1935. (L)

J. W. Gregor and F. R. Horne, M.A. :—

"Growth-forms: genecology and its agricultural significance." Agricultural Progress, Vol. XII., 1934. (P)

William Black, B.Sc., Ph.D. :—

"Studies on the inheritance of resistance to wart disease (*Synchytrium endobioticum* (Schilb.) Perc.) in potatoes." Journ. Genetics, Vol. XXX., No. 1, pp. 127-146, January 1935. (P)

"The resistance of potatoes to wart disease and its inheritance." Experimental Biological Conference, Edinburgh, 14th July 1934. (L)

V. E. M'M. Davey, B.Sc., Ph.D. :—

"Relationships of Species and Smaller Units." Edinburgh Natural History Society, 25th April 1934. (L)

"Turnip Crops and Breeding Methods." Biggar Agricultural Discussion Society, 4th December 1934. (L)

E. C. Barton-Wright, M.Sc., F.R.S.E. :—

"Nitrogen Metabolism of Crinkle-infected Potatoes." The Conference of Virus Diseases of Plants Committee and Workers, 10th July 1934. (L)

George Cockerham, B.Sc. :—

"Inheritance of degeneracy in Potatoes." The Conference of Virus Diseases of Plants Committee and Workers, 10th July 1934. (L)

"Virus Diseases and Potato Breeding." The Conference of the Society for Experimental Biology, 13th July 1934. (L)

"Potato Breeding for Immunity to Virus Diseases." The Imperial Mycological Conference, 21st September 1934. (L)

"Virus Diseases of Potatoes." Transactions of the North-
umberland Agricultural Discussion Society, Vol. IV.,
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Alan M. M'Bain, B.Sc. :—

"Breeding for Resistance to Leaf-Roll in Potatoes."
The Conference of Virus Diseases of Plants Com-
mittee and Workers, 10th July 1934. (L)

III. Demonstrations.

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